

SECTION 9 ELECTRICAL

9.1 General

This section provides general guidelines for the preparation of the electrical input to the design documents required for the Project Implementation Report (PIR) and Plans & Specifications (P&S). Typical design documents include: drawings, specifications, and design analysis as related to power, lighting, grounding, and electronic systems. This section includes specific design requirements that supplement the requirements of General, Section 1 of this manual. All required documents, including drawings and design analysis, shall be in accordance with Graphic Presentation, Section 2 of this manual.

9.1.1 Pumping Stations

Pumping stations are categorized as small-, medium-, and large-sized. For the purpose of this manual, small-sized pumping stations are assumed to have a total pumping capacity of less than 250 cubic feet per second (cfs), medium-sized pumping stations are assumed to have a total pumping capacity from 250 cfs to 1,000 cfs, and large-sized pumping stations are assumed to have a total pumping capacity of over 1,000 cfs. For further information regarding the design of pumping stations for use with Comprehensive Everglades Restoration Plan (CERP) projects, refer to Mechanical, Section 8 of this manual.

Large- and medium-sized pumping stations are usually staffed with operation personnel. Small-sized stations, which are usually seepage stations, are not normally staffed. Unstaffed stations require closed-circuit television (CCTV), intrusion detection, fire alarms, and other systems that relay an adequate presentation of the existing conditions at the station to a remote site. Staffed stations are equipped with similar systems to give the station operator, as well as personnel at the remote site, a real-time picture of the station activities.

All structures shall have the ability for manual operation regardless of the intended mode of operation. The manual controls shall be placed in close proximity to the equipment and give the operator the ability to control the equipment even when automatic or remote operation is off-line.

Small-Sized Pumping Stations

Small-sized pumping stations will typically have one to three pumping systems with a pumping capacity of less than 250 cfs. The prime mover for small-sized pumping stations are electric motors usually coupled directly to the pump. The pumps are expected to run at no less than 600 rpm with an efficiency of 70-80 percent. The electric motor pump drives shall be sized to operate within the medium voltage range (less than 600 volts).

Features of the small-sized pumping station include local-remote-automatic operation, trash rake/rack system, water level sensing, motor control center, telemetry operation via Motorola Supervisory Control and Data Acquisition (MOSCAD) system, and backup generator.

A typical one-line diagram for small-sized pumping stations is shown on Plate E-1. A typical Supervisory Control And Data Acquisition (SCADA) block diagram for small-sized pumping stations is shown on Plate E-2.

Medium-Sized Pumping Stations

Medium-sized pumping stations will typically have three to five pumping systems. The pumps in these stations shall be axial-flow-type vertical-shaft pumps. Power to the pumps shall be provided by a diesel engine through right angle reduction gear drives. Medium-sized pumping stations usually contain an electric motor driven pump for seepage control. The electric motor pump drives shall be sized to operate within the medium voltage range (less than 600 volts).

Features of the medium-sized pumping station include local-remote-telemetry operation, trash rake/rack system, control station/panel with programmable logic controllers (PLCs), fuel transfer system with leak detection, fire alarm, intrusion detection, exhaust fans, cooling water pumps, water level sensing, motor control center, telemetry operation via MOSCAD system, and backup generator.

A typical one-line diagram for medium-sized pumping stations is shown on Plate E-3. A typical SCADA block diagram for medium-sized pumping stations is shown on Plate E-4.

Large-Sized Pumping Stations

Large-sized pumping stations will typically have three to five large capacity pumping systems. Power to the pumps shall be provided exclusively by diesel engines. Large-sized pumping stations usually contain one or more electric motor driven pump(s) for seepage control. The electric motor pump drives shall be sized to operate within the medium voltage range (less than 600 volts).

Features of the large-sized pumping station include local-remote-telemetry operation, trash rake/rack system, control station/panel with PLCs, fuel transfer system with leak detection, fire alarm, intrusion detection, exhaust fans, cooling water pumps, water level sensing, motor control center, telemetry operation via MOSCAD system, and backup generator. Additionally, large-sized pumping stations have a ventilation controlled control room. Operation of the station is characteristically achieved via a SCADA system.

A typical one-line diagram for large-sized pumping stations is shown on Plate E-5. A typical SCADA block diagram for large-sized pumping stations is shown on Plate E-6.

9.2 References

In addition to the following list of codes and standards, all electrical work shall comply with the applicable requirements of the latest edition of the National Electrical Manufacturer's Association (NEMA); Insulated Power Cable Engineer's Association (IPCEA); and all applicable federal, state, city, and local requirements. All newly manufactured equipment shall be listed by the Underwriter's Laboratory (UL) or comparable testing laboratory acceptable to the U.S. Army Corps of Engineers (USACE). When codes conflict, the more stringent standard shall govern.

Civil Works Engineer Manuals (EM)

EM 385-1-1, Safety and Health Requirements Manual

EM 1110-2-2701, Vertical Lift Gates

EM 1110-2-2702, Design of Spillway Tainter Gates

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EM 1110-2-2703, Lock Gates and Operating Equipment

EM 1110-2-2704, Cathodic Protection on Systems for Civil Works Structures

EM 1110-2-3102, General Principles of Pumping Station Design and Layout

EM 1110-2-3105, Mechanical and Electrical Design of Pumping Stations

EM 1110-2-2430, Instrumentation for Concrete Structures

Institute of Electrical and Electronic Engineers (IEEE){tc \12 "17.2.2 Institute of Electrical and Electronic Engineers.}

IEEE 141, *Recommended Practice for Electrical Power Distribution for Industrial Plants* (Red Book)

IEEE 142, *Recommended Practice for Grounding of Industrial and Commercial Power Systems* (Green Book).

IEEE 241, *Recommendation Practice for Electric Power Systems in Commercial Building* (Gray Book)

IEEE 242, *Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems* (Buff Book)

IEEE 399, *Recommended Practice for Industrial and Commercial Power Systems Analysis* (Brown Book)

IEEE 446, *Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications* (Orange Book)

IEEE 493, *Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems* (Gold Book)

IEEE 739, *Recommended Practice for Energy Conservation and Cost-Effective Planning in Industrial Facilities* (Bronze Book)

IEEE 1100, *Recommended Practice for Powering and Grounding Sensitive Electronic Equipment* (Emerald Book)

Instrument Society of America (ISA){tc \12 "17.2.3 Instrument Society of America (ISA).}

ISA 55.1, *Instrumentation Symbols and Identification*

ISA 55.2, *Binary Logic Diagrams for Process Operations*

National Fire Protection Association (NFPA){tc \12 "17.2.4 National Fire Protection Association (NFPA).}

NFPA 70, *National Electrical Code* (Latest Issue)

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NFPA 70E, *Occupational Safety Hazard Agency (OSHA) Electrical Safety Requirements for Employee Workplaces*

NFPA 72, *National Fire Alarm Code*

NFPA 90A, *Installation of Air Conditioning and Ventilating Systems*

NFPA 101, *Safety to Life from Fire in Buildings and Structures*

NFPA 170, *Fire Safety Symbols*

Technical Manuals{tc \l2 "17.2.8 Technical Manuals.}

TM 5-809-11, Design Criteria for Facilities in Areas Subject to Typhoons and Hurricanes

TM 5-811-1, Electric Power Supply and Distribution

TM 5-811-2, Electrical Design: Interior Electrical Systems

TM 5-811-3, Electrical Design: Lightning and Static Electricity Protection

TM 5-811-7, Cathodic Protection

TM 5-811-14, Coordinated Power System Protection

Unified Facilities Guide Specifications (UFGS)

13100A, Lightning Protection System

13110A, Cathodic Protection System (sacrificial anode)

13112A, Cathodic Protection System (impressed current)

13720A, Electronic Security System

13721A, Small Intrusion Detection System

13850A, Fire Detection and Alarm System, Direct Current Loop

13851A, Fire Detection and Alarm System, Addressable

16221A, Electric Motors, 3-Phase Vertical Induction Type

16222A, Electric Motors, 3-Phase Vertical Synchronous Type

16263A, Diesel-Generator Set Stationary 100-2500 KW with Auxiliaries

16403A, Motor Control Centers, Switchboards and Panelboards

16404A, 480-Volt Station Service Switchgear and Transformers

16410A, Automatic Transfer Switch and By-Pass/Isolation Switch

16415A, Electrical Work, Interior

16528A, Exterior Lighting including Security and CCTV Applications

16710A, Premises Distribution System

16751A, Closed Circuit Television Systems

16905A, Electrical Equipment for Gate Hoist

Engineering Technical Letters

- *ETL 1110-3-403, Electrical Power Systems for Non-Linear Loads*
- *ETL 87-9, Prewiring*
- *ETL 91-6, Cathodic Protection*

Miscellaneous References

AEI, *Architectural and Engineering Instructions, Design Criteria*

ANSI-C2, *National Electrical Safety Code*

IESNA 00 (Illuminating Engineering Society of North America), *Lighting Handbook Reference and Application*

NEMA E1 13 (National Electrical Manufacturers Association), *Pulse Initiators for Watt-hour and Other Integrating Meters*

STD 40-06-04, *Lighting Fixtures, Standard Detail No. 40-06-04*
(<http://www.hnd.usace.army.mil/techinfo/index.htm>)

TIA/EIA-606-A (Telecommunications Industry Association / Electronics Industry Alliance), *Administration Standard for the Telecommunications Infrastructure*

CFR 28 Part 36, Nondiscrimination on the Basis of Disability of by Public Accommodation and in Commercial Facilities, Final Edition (ADA)

FED-STD-795, *Uniform Federal Accessibility Standards*
AFM 85-5, Maintenance and Operation of Cathodic Protection Systems.

AFM 91-24, *Energy Management and Control Systems (UMCS [EMCS])*

9.3 Project Implementation Report

The information gathered in each phase of the PIR shall be submitted to the appropriate Project Development Team (PDT) member(s) for incorporation into the Engineering Appendix. The electrical engineer is ultimately responsible for the validity of the information and the correctness

of the design. Prior to final submission, all data used for the design shall be checked thoroughly for errors and conflicts within and between disciplines and proprietary call outs.

9.3.1 Alternatives Evaluation

General Requirements

The Alternatives Evaluation phase is for the collection of information and data necessary to evaluate alternative designs and develop appropriate level cost estimates for comparing these designs. The alternatives are usually driven by hydraulic/hydrology considerations or pump mix determinations; however, the electrical engineer may be asked to participate in a diesel engine versus electric motor comparison.

The following information shall be utilized when preparing the electrical input for the Alternatives Evaluation phase for all types of CERP projects. The Alternatives Evaluation shall include the following requirements as well as all data and calculations made to support design decisions and estimates. The analysis shall also incorporate specific criteria furnished at conference discussions of project features.

Utility Relocations

Utilities include, but are not limited to: electrical, telephone, and cable television lines. During the Alternatives Evaluation phase, coordination with the respective utility owner(s) shall be initiated. The utility owner shall be advised of the project and the proposed period of construction. The utility owner shall be solicited for as-built information for all utilities affected by the project. The focus during the Alternatives Evaluation phase is to identify the utilities that will require relocation due to interference with project features.

The following requirements are applicable for all project types and are intended to provide guidance for evaluating utilities that may potentially interfere with project features:

- Obtain as-built information on all known existing aerial, underground, and/or supported utilities entering, exiting, and within the project area.
- Request assistance from the respective utility owner to obtain as-built information for any utilities in the project area.

Instrumentation and Controls

The electrical engineer shall evaluate each alternative to determine the instrumentation and controls requirements.

The following items shall be performed:

- Coordinate the following project features with the local project sponsor: local, remote, and/or telemetry operation of equipment; intrusion detection; CCTV; SCADA; and water level sensor needs.
- MOSCAD, SCADA, PLC are used by South Florida Water Management District (SFWMD) for remote operations. The pump stations and spillways shall have two modes of operation: local and remote. The local operation shall not be dependant upon the MOSCAD or SCADA, but instead shall be totally functional in the event of a MOSCAD or SCADA failure.

- At locations where CCTV is required, the design shall incorporate adequate bandwidth using microwave communications.
- Pumping stations shall contain a Station Control Center (SCC) with a PLC to provide for monitoring and control of common station functions such as backup generators, fire alarms, fuel system leak detection and level monitoring, security alarms, trash rakes, and ventilation fans. In pumping stations with an office there shall be a computer to allow for interface with the pumping station control system for monitoring and control.
- The electrical engineer shall coordinate with the local sponsor the requirements for automatic or manual operation as well as manned and unmanned pumping station or spillway.
- Develop a plan view with typical controls layout.
- Provide the cost estimator with an estimation of costs for instrumentation and control components.

Pumping Stations

The electrical engineer shall evaluate each alternative to determine the electrical requirements. Information for the electrical design of pumping stations can be found in EM 1110-2-3102 and EM 1110-2-3105. Items to consider for the electrical design include: establishing main service to the structure, identifying special loads within or around the structure, identifying needs of the local sponsor regarding local-remote-telemetry operation, and providing power to all electrically-operated equipment and devices.

The electrical engineer shall perform the following for each plan:

- Determine the route of electrical service from the nearest or most feasible distribution line to the project site. Coordinate the route with the local utility owner and other PDT members.
- Coordinate, with the local utility owner, the cost of bringing the required level of electrical service to the site.
- Develop electrical load requirements from pump mix, ancillary equipment, and lighting loads. Provide a brief description of the electrical characteristics (i.e., phase and voltage) for the electrical system(s).
- Develop requirements for a backup generator. Limit the size of the generator to only power equipment directly involved in the flood control mission.
- Determine the estimated cost for supplying electrical service and generator to the cost estimator. Provide the cost estimator with any known cost of electrical components or systems derived through discussions with manufacturers.
- Develop vertical and horizontal working clearance requirements to the structural engineer for station geometry (i.e., height and width) considerations.
- Develop a list of sole source items with justification for approval. Sole source items may include: Onan generators, Onan transfer switch, Bindicator and Balluff water level sensors, fire alarm systems, MOSCAD and CCTV systems or components.

Spillways or Gated Culverts

The electrical engineer shall evaluate each alternative to determine electrical requirements. Information regarding the design of spillways and gated culverts can be found in EM 1110-2-2701 and EM 1110-2-2702.

The following items shall be performed if the project contains a spillway or gated culvert(s).

- Determine the route of electrical service from the nearest or most feasible distribution line to the project site. Coordinate the route with the local utility owner and other PDT members.
- Develop requirements for a backup generator. Limit the size of the generator to only power equipment directly involved in the flood control mission.
- Determine if an electronic Manatee Protection System (MPS) is required for the structure. If a MPS is required, the electrical engineer shall specify the bumper type system for spillways.
- Determine the estimated cost for supplying electrical service and generator, and furnish these data to the cost estimator. Provide the cost estimator with any known cost of electrical components or systems derived through discussions with manufacturers.

The electrical engineer shall coordinate equipment utilization with the mechanical engineer. Care shall be taken to provide adequate power and control for all equipment at the spillway or gated culvert.

Required Documentation/Products

1. Narrative

The electrical engineer shall provide a descriptive narrative describing the electrical features of each of the alternatives considered. The narrative shall discuss utility relocation, plans for providing new service or upgrading the existing service, interior electrical requirements, and other electrical requirements that are unique to the respective design. The level of coordination with local utility owners shall be defined, as well as the suggested method for resolution of problematic issues.

The narrative shall also include a discussion of the following items:

- a. Physical characteristics of overhead and/or underground utilities within the project area, as well as those entering and exiting the project area.
- b. Control scheme for major equipment. Discussions on local-remote-telemetry operations and manual-automatic starting shall also be included.
- c. Backup generator and the items within the structure that shall be powered by the generator.
- d. Trash cleaning system and mode of operation.
- e. Water level sensors.
- f. Requirements relating to station and engine PLC(s), SCADA, MOSCAD, and telemetry. The physical components as well as the mode of operation shall be discussed.

2. Drawings

The Alternatives Evaluation phase electrical drawings shall be limited to an existing utility site plan and a plan view of temporary and permanent routes for any affected utilities.

9.3.2 Design of Tentatively Selected Plan**General Requirements**

Work accomplished during the Design of Tentatively Selected Plan (TSP) phase shall include the requirements stated within the following paragraphs, all data collected, calculations performed to support any design decisions, and the cost estimate for this phase of design. It shall also incorporate specific criteria furnished at conference discussions of project features.

Utility Relocations

The following items shall be performed for electrical utility relocations, and shall include telephone and cable television lines:

- Coordinate/establish, with utility owner(s), the local sponsor, and the civil-site engineer, temporary and/or permanent relocation of utilities that interfere with project features.
- Obtain a written, estimated cost to relocate a utility and the intentions that the utility owner(s) to perform the relocation. If the utility owner does not assume the responsibility of relocating the utility, provide workmanship, safety, and equipment standards to the contractor performing the work. Economic feasibility and the reliability of various power factor correction schemes shall be considered by the electrical engineer designing the relocation scheme.
- Request a life-cycle analysis of the existing utility from the utility owner.
- Coordinate and clearly detail the level of work required by the utility owner and the project's construction contractor for any utility relocation.

Instrumentation and Control

The electrical engineer shall match the instrumentation and controls with the project requirements and specify the equipment most likely to be used during the TSP phase.

The following items shall be performed:

- Identify the equipment starter type.
- Develop an initial telemetry plan.
- Develop typical control schematic(s) and operating sequence(s).
- Determine water level sensor needs.
- Prepare tentative control panel layouts for motor control centers and/or engine control panels.

Exterior Electric and Other Utilities

The following guidelines have been developed for the most common projects such as locks and/or spillways and minor exterior electrical design. The requirements shall be defined, developed, and agreed to during this phase. Projects, which require extensive exterior electrical work, and projects with complicated or highly technical interior electrical work shall have special requirements developed for the respective project. The design shall be complete and accurate and checked by the electrical engineer to ensure compliance with project criteria. It shall be thoroughly checked for errors and conflicts within and between disciplines and proprietary requirements. No proprietary equipment shall be included in the design unless specifically authorized. The electrical engineer's focus shall be directed toward identifying, sizing, and


quantifying the major pieces of equipment that shall be included in the pumping station.

The electrical engineer shall:

- Coordinate with the local utility owners to arrange for electric power and telephone service if needed.
- Obtain from the utility owner any available information regarding existing utility lines within the project area and any necessary work needed to bring the required utility to the project.
- Determine with the utility owner whether the existing utility requires upgrades (i.e., single phase to three phase and/or 120 volts to 480 volts).
- Provide main service to the structure and provide necessary distribution devices to all equipment and electronics requiring power.

The following is a list of design requirements for elements relevant to the electrical design:

1. Transformer

Although the local utility owner provides the transformer, the electrical engineer shall specify a delta-wye  type transformer to block transit frequency.

Additionally, the electrical engineer shall obtain information about the transformer from the utility owner, including:

- Type
- Number
- Capacity (kVA)
- Impedance
- Statement of the method of sizing

2. Lightning Protection System

Describe the lightning protection system; if protection is not required, an explanation shall be provided. Design requirements shall be based on TM 5-811-3 and EM 385-1-1.

3. Site and Station Grounding

The electrical engineer shall evaluate the grounding plan and discuss real estate requirements with other disciplines as necessary. The grounding system to be installed shall be described. If a counter poise, a grid, or EMI shielding requirements are to be used, state the standards in design calculations.

4. Backup Generator

Spillways shall have a backup generator to provide power for essential flood control equipment and station lighting. The electrical engineer shall coordinate with the local sponsor, hydraulic/hydrology and mechanical engineers for other items that require backup power.

5. Telecommunications/Data System

Provide a descriptive narrative of all electronic systems that are required for the project.

6. One-Line Diagram

Prepare a one-line diagram from the service drop to secondary panels including major equipment.

7. Control Centers Suggested Layouts

Prepare tentative control panel layouts for motor control centers and/or engine control panels.

8. Intrusion Detection System

Pump stations shall be equipped with electronic intrusion detection. The system shall operate such that, upon intrusion, an alarm shall be sounded in the station and registered at a remote location.

9. Cathodic Protection System

Clearly define areas of structures or components in soil or water to be protected. Indicate the type of system recommended, comparison of systems, and a cost estimate.

10. Fire Detection and Alarm System

The pump station shall be equipped with a fire detection/alarm system in accordance with NFPA 72 National Fire Alarm Code.

11. Manatee Protection System

For spillways located in areas that are frequently visited by manatees, the designer shall specify a bumper type manatee protection system. The manatee protection system control shall be integral to the spillway controls.

12. Gate Position Indicator with Display

Spillways shall have an installed gate position indicator with display. The indicator shall be capable of providing an electrical signal to the PLC.

13. Pushbutton Control Station

The spillway shall have a pushbutton control station on the walkway and in the control building for local and remote control, respectively.

Required Documentation**1. Narrative**

The narrative shall describe the features of the TSP and include, but not be limited to, the following:

- a. An explanation of any utility relocation divided into: the work to be performed by the local utility owner and the work that will need to be performed by the project contractor.
- b. Electrical characteristics of new power supply from the service point to the main service equipment (i.e., voltage and phase).
- c. Description of operation, which shall include requirements for local-remote-telemetry operation.
- d. Description/characteristics of auxiliary equipment and/or systems. A brief discussion on each auxiliary system shall be provided.
- e. All sole source items and a brief discussion justifying the need for sole sourcing.
- f. A discussion of the physical characteristics of overhead and/or underground utilities within the project area, as well as those entering and exiting the project area.
- g. Provide a discussion of the control scheme for major equipment. Discussions on local-remote-telemetry operations and manual or automatic starters shall also be included.
- h. A discussion of backup power generation and the items within the structure that shall be powered by the generator.
- i. A discussion of trash cleaning systems and mode of operation.
- j. A discussion of water level sensors. If sensors are to be provided as sole source, then a narrative shall be provided for the justification for the sole source item.
- k. A discussion of requirements relating to station and engine PLC(s), SCADA, MOSCAD, and telemetry. The physical components, as well as the mode of operation, shall be discussed.

2. Drawings and Plates

Drawings and plates shall graphically present the design as finalized in the TSP phase.

The information presented shall be specific to the TSP and include, but not be limited to, the following:

- a. An electrical site plan that includes existing utilities and illustrates the proposed routes for temporary or permanent utility relocation.

- b. A typical one-line diagram showing power distribution from the service pole to the load panels.
- c. A typical control schematic for the main drive unit and a separate control schematic for each major auxiliary equipment type (i.e., fuel oil pump, raw water supply pump, and vacuum pump).

3. Sample Drawings

The typical drawings are provided to serve as a guide to the level of information that shall be conveyed. The drawings are representations and shall be revised as necessary to adequately reflect the features of the TSP. Examples of these drawings are as follows:

- Panel Schedule (E-15)
- Lighting Fixture Schedule (E-18)
- Conduit and Cable Schedule (E-16/17)

General Requirements

The following requirements apply to the development of plans and specifications for the design of electrical systems. These requirements are applicable to all CERP projects.

Power Supply

Coordinate with the local power owner to bring in a new service or convert a single-phase service into a three-phase service. Conductors shall be copper except for overhead high voltage and distribution voltage (i.e., 12470Y/7280V), which are generally aluminum.

The electrical engineer shall coordinate the location of all major pieces of electric equipment, including panel boards, with the structural and mechanical engineers.

Plans

{tc \12 "17.4.1 Interior Electrical System Design Analysis Narrative.}

Plans shall graphically present the design and include the following:

1. General

An electrical symbols and legend drawing shall be prepared.

2. Utility Relocation

A demolition plan for any existing utility requiring removal and/or demolition shall be prepared.

3. Electrical Site Plan

An electrical site drawing indicating the locations of the following items shall be prepared:

- Service into the site
- Transformer pad(s)

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- Conduit runs for primary and secondary power

Existing and new electrical primary lines both overhead and underground shall be properly identified. Any removals and/or relocations of electrical components shall be shown. If work to be completed is so extensive that the clarity on the plan is diminished, additional drawings shall be provided. The secondary service to the facility and whether it is to be routed overhead or underground shall be indicated.

4. Lightning Protection and Grounding Plan

A lightning protection plan and grounding plan shall be prepared. The lightning protection plan shall show the location and detail of air terminal, down conductor location, and grounding grid or counter poise system.

5. One-Line Diagram

A one-line diagram that shows the main electrical service and secondary transformers, metering equipment, major electrical components, power panels, and lighting panels shall be prepared. The type, number, capacity (kVA), and impedance of the proposed transformer installation and state the method of sizing shall be indicated.

6. Conduit Plan

A conduit plan that shows location of switchgear, control centers, panel boards, motors, and disconnects shall be prepared. The conduit and cable plan shall include all power, control, communications, and alarm cables.

7. Intrusion/Fire Detection Plan

An electrical floor plan that includes fire alarm and security devices shall be prepared. A riser diagram for fire alarm, telecommunications/data systems, security alarms with all devices shown, zones, and wiring shall be prepared.

8. Lighting Plan

A lighting layout, receptacles, and telephone jack location plan shall be prepared. The lighting system(s) shall include in tabulation form, the lighting intensity, type of fixture, number of lights, and wattage.

9. Control Schematic and Plan

Control schematics for each component shall be prepared. A control plan indicating the conduit and cable size for all control circuits shall be prepared.

10. Conduit and Cable Schedule

Conduit and cable schedules that include source and designation of conduit, conduit size, number of conductors, and purpose of the circuit shall be prepared.

11. Suggested Control Center Layout

Suggested layouts for Motor Control Center (MCC), Engine Control Center (ECC), Spillway Control Center (SCC), and gate control panels shall be prepared. The layouts shall include all controls, meters, alarms, and PLC displays. Gate control panels shall also include an interior layout. Panel board schedules shall include Amperes Interrupting Capacity (AIC) ratings, voltage, breaker size, and voltamp requirements of each circuit.

12. Hazardous Areas at Fuel Farms

Any and all hazardous areas shall be defined with the applicable class, group, division, and suitable operating temperature as defined by the National Electrical Code. Do not attempt to “design around” the hazardous areas in lieu of designating the areas. Source of criteria, such as Safety Officer or some other recognized official shall be provided, and documentation of the source shall be included.

13. Equipment Grounding Plan

An equipment grounding plan showing the location of major equipment with grounding conductor, building grounding conductor, and grounding loop shall be prepared.

14. SCADA Logic Diagram

A SCADA Logic Diagram that shows the operating logic, inputs and outputs, computer location, and other components of the SCADA system shall be prepared.

15. MOSCAD Plan

A MOSCAD plan that identifies the system components and location within the structure shall be prepared.

Specifications

The current guide specifications utilized by the USACE are known as the Unified Facilities Guide Specifications (UFGS). The electrical specifications are numbered within sections 16000 to 16999. However, numbers are not consecutive and not all numbers are used. The electrical engineer shall be aware that specifications covering special items such as cathodic protection are contained in section 13000. The electrical engineer will need input from the mechanical engineer to complete the generator specifications.

The electrical engineer shall edit the guide specifications to reflect the equipment that is being selected for the project. Care shall be exercised to ensure that conflicts between specifications sections are eliminated.

Required Documentation/Products

The electrical engineer shall furnish supporting documentation consisting of Design Analysis (DA), Design Documentation Report (DDR), and Engineering Documentation Report (EDR) to adequately document the approach, assumptions, decisions, and equipment selection criteria that yielded the final design.

Design Analysis

The DA shall document all alternatives considered for a project feature and the reasoning for selection or rejection. The electrical engineer shall evaluate at least three different supplier's equipment and design to the most conservative (i.e., the largest when space is a factor, or the slowest when speed is a factor). The DA shall include the following:

- A documented statement that the primary supply is adequate to support the added load. If the primary source is inadequate, stated measures proposed to correct the deficiency in the design shall be included. Reference photographs of existing substations, pole line structures, and/or other exterior components shall be included. The photographs shall be included in the design analysis of all affected equipment and structures.
- Where additions or alterations to existing systems are to be made, systems that are expandable and can accommodate these changes shall be verified. A description of all proposed additions and alterations to each system shall be provided.
- Any additional criteria, deviations concerning criteria, questions or problems shall be listed.

Design Documentation Report

The DDR shall document the final design. The electrical engineer shall include in the DDR, pertinent and relevant information about the equipment contained in the design. Documentation shall be included in the DDR that clearly indicates that the selected equipment matches the project feature. Manufacturer's catalog cut, specification sheets, installation instruction, and cautions, may be included in this report. Engineering considerations and instructions to construction personnel or equipment operators may also be included. As a minimum, the DDR shall include the following:

- A statement describing standards of design, such as primary and secondary voltage drop, and physical characteristics of overhead or underground circuits. If underground, state the basis for the selection and reference applicable conclusions and/or calculations. State short circuit current available at project site and the source of this data.
- A statement describing all exterior lighting, with handicapped features if required. IES point-to-point calculations shall be submitted to support the selection for the aforementioned lighting system.
- A statement describing the extent of any exterior work, such as telephone lines and duct banks, outside of five feet from the building line.
- A descriptive narrative of all electronic systems, which are required for the project. A list of possible electronic components and/or systems that may be required on a given project are as follows: Telecommunication/Data Systems, Fire Detection and Alarm System Fire Suppression System Controls, Cathodic Protection, Special Grounding Systems, Public Address Systems, and Security Systems.
- Any additional criteria, deviations concerning criteria, questions or problems.

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[P1]Is this correct? kp